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ORIGINAL ARTICLE

# Vitamin D deficiency in a multinational refugee population

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## Abstract

**Background:** Populations with increased skin pigmentation who have migrated to countries of high latitude are at increased risk of low vitamin D. This study aimed to determine the prevalence of low vitamin D among the refugee population arriving in New Zealand.
**Methods:** An audit of all refugees arriving at the national refugee resettlement centre from May 2004 to May 2005 was carried out. Serum 25-hydroxyvitamin $D_3$ levels were measured and defined as normal (50–150 nmol/L) or low, with low subdivided into insufficient (25 to <50 nmol/L) and deficient (<25 nmol/L). Whether vitamin D status varied with age and sex was determined.
**Results:** Vitamin D was measured in 869 (99%) of the refugees and was low in 470 (54%, 95% confidence interval (CI) 51–57%). It was insufficient in 323 (37%, 95%CI 34–41%) and deficient in 147 (17%, 95%CI 15–20%). Female sex was associated with at least a 10 times increased risk of vitamin D deficiency (relative ratio 13.93, 95%CI 10.15–17.96). Women aged between 17 and 45 years and men aged 46 years and more were at greatest risk.
**Conclusion:** Poor vitamin D status is prevalent among refugees arriving in New Zealand. Women, particularly those of child-bearing age are at greatest risk. Screening and ongoing surveillance for vitamin D deficiency should be considered for all recent refugee immigrants to New Zealand.

## Introduction

Vitamin D plays an integral part in maintaining bone health. Its role in other body systems is being increasingly recognized. Vitamin D determines immune function and is a potent antiproliferative and pro-differentiation agent. It is thought to play a protective role in several disease processes, including autoimmune skin disease, diabetes mellitus and some cancers.[1,2]

Those who do not receive adequate, direct sun exposure to their skin are the group most at risk of low vitamin D. Contributing factors include increased skin pigmentation, living at a high altitude, staying indoors or covering the skin while outside. As vitamin D is present in foods, such as fatty fish, cod liver oil, egg yolk, milk and meat, vegan dietary practices can result in low vitamin D.[3,4] Exclusively breast-fed infants whose mothers have low vitamin D are also at risk.[5,6]

In the developed world, high-risk groups are those with increased skin pigmentation who have migrated to countries of high latitude, especially if these people cover their skin when outside.[7] In Australia, dark-skinned women, particularly if veiled and mothers of infants with rickets have been shown to be at increased risk of low vitamin D.[8–12]

In New Zealand, refugee migrants are an identifiable group who would be expected to be at increased risk of low vitamin D. The United Nations High Commission for Refugees decides the refugees who are in the greatest need of resettlement. Each year New Zealand accepts 750 such people under the Refugee Quota Programme.[13]

This audit aimed to measure the prevalence of low vitamin D among the refugee population arriving in New Zealand particularly focusing on children aged 0–16 years and

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women of reproductive age. The intention of this audit was to determine whether ongoing screening was warranted.

## Methods

The Auckland Regional Public Health Service at the Mangere Refugee Resettlement Centre, Manakau City, New Zealand provides health checks and screening for approximately 750 refugees a year. This check occurs as part of a compulsory orientation programme at the centre during the first 6 weeks of settlement in New Zealand.[13] Measurement of vitamin D is part of the routine screening carried out. As this was an audit of this routine test, ethical approval was not required.

From 1 May 2004 to 19 May 2005, all refugees undergoing health screening at the medical clinic of the Mangere Refugee Resettlement Centre had their 25-hydroxyvitamin $D_3$ concentrations measured. Blood for measurement of vitamin D status was obtained within a few days of each refugee's arrival. Vitamin D was measured by LabPlus at Auckland City Hospital using either a DiaSorin Radioisotope Assay (DiaSorin S.p.A., Saluggia, VC Italy) (before November 2004) or a Nichols Advantage immunochemiluminometric assay (Nichols Institute Diagnostics, San Clemente, CA, USA) (from November 2004). These assays are similar and have the same normal reference range of 50–150 nmol/L. Their comparability was confirmed by both a Labplus in-house assay comparison and a Vitamin D External Quality Assessment Scheme (DEQAS) international external quality assurance programme (Dr J. Davidson, Clinical Head, Department of Chemical Pathology, Labplus, Auckland City Hospital, pers. comm., 2006).

Testing was undertaken throughout the year. Abnormal results were entered into the centre's primary care database as they were received by the referring doctor. Vitamin D levels less than 50 nmol/L were defined as abnormally low. Low vitamin D levels were subdivided into insufficient (25 to <50 nmol/L) or deficient (<25 nmol/L). The lower level corresponds with a widely accepted definition of frank deficiency, whereas the higher level indicates a suboptimal bone health.[11,14,15]

Refugees with low vitamin D levels were offered treatment with a single large dose of vitamin D. Some also received ongoing supplementation.

Data abstracted electronically included age, sex, ethnicity (as opposed to country of origin), vitamin D status (high, normal, insufficient and deficient) and the date this result was received at the clinic. This dataset was imported into and analysed with SAS version 9.1 (Cary, NC, USA).[16] Proportions were compared using the $\chi^2$-test or the Fisher exact test. Continuous variables that were not normally distributed were compared using the Wilcoxon rank sum test.

Associations of age and sex with the risk of any abnormally low vitamin D level and of milder (vitamin D insufficiency) and more severely abnormal (vitamin D deficiency) vitamin D status were determined using logistic regression. As this was a study of a cohort in which abnormal vitamin D status was predicted to be prevalent, relative risks (RR) and 95% confidence intervals (CI) were approximated from the adjusted odds ratios and 95%CI.[17]

## Results

### Study sample characteristics

Eight hundred seventy-five refugees were seen during the study interval. The median age (25–75th centile) was 17 years (9–27 years). Of the sample, 433 (49%) were 16 years of age or younger. Of these 433 children, 102 (24%) were 0–5 years old, 148 (34%) were 6–10 years old and 183 (42%) were 11–16 years old.

Four hundred and twenty-seven (49%) were of female sex of whom 194 (45%) were 16 years of age or younger, 194 (45%) were 17–45 years old and 39 (10%) were 46 years or older. The proportion of the sample that was of female sex did not differ in the three age groups ($\chi^2 = 5.50$, $P = 0.06$).

Ethnicity was stated for 872 (99%) of the 875 refugees. The ethnicity of the sample is shown in Figure 1. The predominant ethnic group was Afghan (53%) with most of the remainder being Burundian (9%), Sudanese (9%), Ethiopian (7%), Somali (7%), Iraqi (6%) and Djiboutian

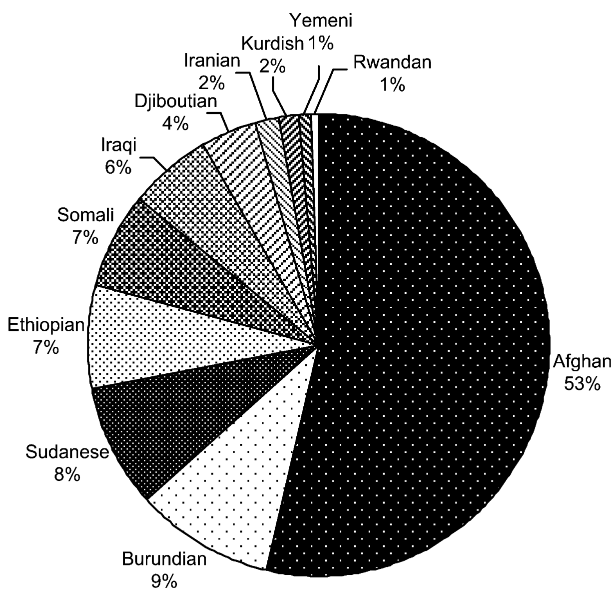


**Figure 1** Ethnicity (%) of the 875 refugees included in the audit of vitamin D status. The remaining 10 included 2 each who were Congolese, Eritrean, Sri Lankan and Burmese, 1 Chadian and 1 was African, but ethnicity not further specified.

(4%). The remaining 5% of the sample included small numbers from 10 other ethnic groups. The different ethnic groups did not vary by age or sex (data not shown).

## Vitamin D status of study sample (Table 1)

Serum vitamin D concentration was measured in 869 (99%) of the sample. Vitamin D was normal in 389 (45%, 95%CI 42–48%) and low in 470 (54%, 95%CI 51–57%). Of those with low vitamin D, vitamin D was insufficient in 323 (69%, 95%CI 65–73%) and deficient in 147 (31%, 95%CI 27–36%). In 10 (1%) of the sample, vitamin D was increased.

Low vitamin D was prevalent in both the female (73%) and male (37%) sexes with the risk for the former being greater (RR = 1.97, 95%CI 1.80–2.11). The risk for the female sex became more marked as the severity of vitamin D deficiency increased.

Vitamin D levels were low in 52% of those aged 0–16 years, 55% of those aged 17–45 years and 66% of those aged 46 years and older. In comparison with the youngest age group, refugees 46 years and older were at increased risk of low vitamin D (RR = 1.26, 95%CI 1.05–2.97). Both older age groups were at increased risk when the analysis included only those with the most abnormal vitamin D levels.

The association between vitamin status and age varied with sex. When compared with the female children aged 0–16 years, there was an increased risk of low vitamin D in women aged 17–45 years (RR = 1.14, 95%CI 1.00–1.25), but not those aged 46 years and more (RR = 0.96, 95%CI 0.70–1.19). In contrast, for men there was an increased risk for those who were 46 years and older (RR = 1.84, 95%CI 1.24–2.43), but not for the middle-aged group (RR = 0.75, 95%CI 0.53–1.01).

## Vitamin D status of children (Table 2)

Low vitamin D levels were prevalent in both girls (69%) and boys (39%) with the risk for girls being greater (RR = 1.78, 95%CI 1.54–1.98). The risk for girls became more marked as the severity of vitamin D deficiency increased.

Low vitamin D levels were present in 27% of children 5 years of age or younger, 48% of children 6–10 years old and 69% of children 11–16 years old. Compared with the youngest age group, children aged 6–10 years (RR = 1.76, 95%CI 1.26–2.28) and 11–16 years (RR = 2.55, 95%CI 2.08–2.95) were at increased risk of low vitamin D with the risk being greater for those with more severe vitamin D deficiency.

There was association of increased risk of poor vitamin D status with increasing age for both girls and boys. Compared with those who were 0–5 years old, there was an increased risk of low vitamin D for girls aged 6–10 years (RR = 1.79, 95%CI 1.22–2.26) and 11–16 years (RR = 2.37, 95%CI 1.98–2.60). In comparison with the youngest age group, boys aged 6–10 years were not at increased risk (RR = 1.65, 95%CI 0.95 to 2.59), but boys aged 11–16 years were (RR = 2.48, 95%CI 1.63–3.36) at an increased risk of low vitamin D.

## Vitamin D status in women of child-bearing age (Table 3)

Seventy-eight per cent of the 192 women in this group had low vitamin D with 71 (37%) being vitamin D insufficient

**Table 1** Vitamin D status of the refugees by age and sex

| | Serum vitamin D (*n* = 859)† *n* (%) | | | Risk of being insufficient RR (CI)‡ | Risk of being deficient RR (CI)‡ |
|---|---|---|---|---|---|
| | Normal 389 (45) | Insufficient§ 323 (38) | Deficient 147¶ (17) | | |
| Age (years) | | | | | |
| 0–16 | 200 (48) | 173 (41) | 47 (11) | 1.00 | 1.00 |
| 17–45 | 164 (45) | 120 (33) | 82 (22) | 0.91 (0.75, 1.08) | 1.75 (1.31, 2.27) |
| 46 and older | 25 (34) | 30 (41) | 18 (25) | 1.18 (0.87,1.47) | 2.20 (1.39, 3.09) |
| Sex | | | | | |
| Male | 276 (63) | 153 (35) | 11 (3) | 1.00 | 1.00 |
| Female | 113 (27) | 170 (41) | 136 (32) | 1.70 (1.48, 1.90) | 13.93 (10.15, 17.96) |
| Age group (female) (years) | | | | | |
| 0–16 | 58 (31) | 88 (47) | 42 (22) | 1.00 | 1.00 |
| 17–45 | 42 (22) | 71 (37) | 79 (41) | 1.06 (0.79, 1.34) | 1.55 (1.24, 1.82) |
| 46 and older | 13 (33) | 11 (28) | 15 (39) | 0.70 (0.35, 1.16) | 1.28 (0.79, 1.74) |
| Age group (male) (years) | | | | | |
| 0–16 | 142 (61) | 85 (37) | 5 (2) | 1.00 | 1.00 |
| 17–45 | 122 (70) | 49 (28) | 3 (2) | 0.74 (0.52, 1.02) | 0.70 (0.14, 2.80) |
| 46 and older | 12 (35) | 19 (56) | 3 (9) | 1.79 (1.16, 2.43) | 6.33 (1.32, 20.04) |

†Of the 875 refugees that formed the study sample, vitamin D was not measured in 6 and was increased in 10. ‡In comparison with those with normal vitamin D status. §Serum vitamin D 25 to <50 nmol/L. ¶Serum vitamin D <25 nmol/L. CI, confidence interval; RR, relative ratio.

**Table 2** Vitamin D status of children aged 0–16 years by age and sex

| | Serum vitamin D ($n$ = 420)† $n$ (%) | | | Risk of being insufficient RR (CI)‡ | Risk of being deficient RR (CI)‡ |
|---|---|---|---|---|---|
| | Normal 200 (48) | Insufficient§ 173 (41) | Deficient¶ 47 (11) | | |
| Age (years) | | | | | |
| 0–5 | 67 (73) | 24 (26) | 1 (1) | 1.00 | 1.00 |
| 6–10 | 77 (52) | 65 (44) | 5 (3) | 1.74 (1.23, 2.30) | 4.21 (0.68, 46.02) |
| 11–16 | 56 (31) | 84 (46) | 41 (23) | 2.29 (1.75, 2.79) | 33.13 (9.30, 89.92) |
| Sex | | | | | |
| Male | 142 (61) | 85 (37) | 5 (2) | 1.00 | 1.00 |
| Female | 58 (31) | 88 (47) | 42 (22) | 1.62 (1.33, 1.88) | 12.96 (6.90, 21.89) |
| Age group (female) (years) | | | | | |
| 0–5 | 23 (64) | 12 (33) | 1 (3) | 1.00 | 1.00 |
| 6–10 | 22 (36) | 36 (58) | 4 (6) | 1.82 (1.19, 2.35) | 3.71 (0.57, 19.51) |
| 11–16 | 13 (14) | 40 (44) | 37 (41) | 2.21 (1.62, 2.62) | 18.29 (8.31, 24.41) |
| Age group (male) (years) | | | | | |
| 0–5 | 44 (79) | 12 (21) | 0 (0) | 1.00 | 1.00 |
| 6–10 | 55 (65) | 29 (34) | 1 (1) | 1.62 (0.92, 2.55) | 0.79 (0.02, ∞) |
| 11–16 | 43 (47) | 44 (48) | 4 (5) | 2.38 (1.53, 3.28) | 5.23 (0.63, ∞) |

†Of the 433 children vitamin D was not measured in 6 and was increased in 7. ‡In comparison with those with normal vitamin D status. §Serum vitamin D 25 to <50 nmol/L. ¶Serum vitamin D <25 nmol/L. CI, confidence interval; RR, relative ratio.

and 79 (41%) vitamin D deficient. Compared with the youngest age group, those aged 26–35 years were at less risk of low vitamin D (RR = 0.70, 95%CI 0.43 to 0.98).

### Vitamin D status and ethnicity

The proportion of each ethnic group with low vitamin D is shown in Table 4. The frequency of low vitamin D varied with ethnicity from 0 to 80%. Low vitamin D was present in 50% or more of the Afghan, Iraqi, Djiboutian, Ethiopian, Iranian, Kurdish and Yemeni groups. Within each ethnic group, the frequency of low vitamin D among children was similar to that for the entire sample and among women of child-bearing age it tended to be higher.

## Discussion

Vitamin D status was abnormally low in 54% of this refugee population. Seventy-eight per cent of women of reproductive age had low vitamin D. Even in the age and gender group at lowest risk, boys 0–5 years old, vitamin D was low at 21%.

The risk of both vitamin D insufficiency and deficiency varied with sex and age with the age associations varying with sex. In the female sex vitamin D status appeared to deteriorate from school age onwards with the increased risk of low vitamin D persisting approximately to menopause. In the male sex there was some increased risk of vitamin D insufficiency around the age of puberty and then an increased risk of both vitamin D insufficiency and deficiency for those at age 46 years and older.

The increased risk of low vitamin D for women is consistent with that of other reports and has been described for recent immigrant populations in Australia.[9,11] The female age variance in risk seen in this study emphasizes the vulnerability of refugee women to low vitamin D throughout their child-bearing years. This must also place their newborn infants at risk and indicate the need for vitamin D supplementation of all such infants if they are breast-fed.[6] For the male sex the poorer vitamin D status later in life

**Table 3** Vitamin D status of women of child-bearing age by age

| | Serum vitamin D ($n$ = 192)† $n$ (%) | | | Risk of being insufficient RR (CI)‡ | Risk of being deficient RR (CI)‡ |
|---|---|---|---|---|---|
| | Normal 42 (22) | Insufficient§ 71 (37) | Deficient¶ 79 (41) | | |
| Age group | | | | | |
| 17–25 | 16 (17) | 37 (40) | 40 (43) | 1.00 | 1.00 |
| 26–35 | 18 (32) | 16 (29) | 22 (39) | 0.67 (0.39, 0.98) | 0.77 (0.48, 1.04) |
| 36–45 | 8 (19) | 18 (42) | 17 (40) | 0.99 (0.65, 1.24) | 0.95 (0.61, 1.21) |

†Of the 194 women of child-bearing age vitamin D was increased in two. ‡In comparison with those with normal vitamin D status. §Serum vitamin D 25 to <50 nmol/L. ¶Serum vitamin D < 25 nmol/L. CI, confidence interval; RR, relative ratio.

 

**Table 4** Frequency of low vitamin D by ethnicity

| Ethnic group (*n* for all refugees) | *n* (%) with low vitamin D† | | |
|---|---|---|---|
| | All refugees | Children 0–16 years | Women of child-bearing age |
| Afghan (461) | 308 (67) | 148 (63) | 92 (98) |
| Burundian (74) | 13 (18) | 8 (20) | 2 (13) |
| Sudanese (71) | 5 (7) | 1 (3) | 3 (20) |
| Ethiopian (61) | 34 (56) | 15 (56) | 14 (74) |
| Somali (57) | 28 (49) | 13 (46) | 8 (73) |
| Iraqi (51) | 41 (80) | 18 (78) | 13 (93) |
| Djiboutian (32) | 17 (53) | 6 (40) | 7 (100) |
| Iranian (14) | 9 (64) | 6 (86) | 2 (67) |
| Kurdish (14) | 7 (50) | 2 (40) | 4 (67) |
| Yemeni (6) | 3 (50) | 1 (33) | 2 (67) |
| Rwandan (5) | 0 (0) | 0 (0) | 0 (0) |

†Serum vitamin D <50 nmol/L.

may increase their risk of several chronic diseases, including diabetes and cardiovascular disease.[1,2,18]

The large variability in the frequency of low vitamin D with ethnicity is likely to be because of several factors. Ethnicity encompasses country of origin, pigmentation of skin, dietary factors and cultural practices relating to sun exposure. For refugee groups it also can be an indicator of recent deprivation, internment and prejudice all of which could contribute to the poor vitamin D status.

The lower prevalence of vitamin D insufficiency and deficiency in younger children is somewhat surprising given the high prevalence in women of child-bearing age. Children of mothers with low vitamin D are at increased risk.[6] This sample included only a small number of infants, the age group in whom vitamin D status is most closely related to maternal status.[5,19] The lower prevalence in children may reflect greater sunlight exposure through play and less need culturally to be fully covered when outside. Even in fully breast-fed infants, vitamin D levels in the first 6 months of life correlate with sunlight exposure.[20]

This was a limited audit of vitamin D status to determine whether to continue vitamin D screening of all refugees. No data were available on the relatedness or family groupings within this sample or on several factors that have been shown to influence vitamin D status. Factors that might be important are cultural practices relating to sun exposure, such as amount of covering worn while outside, the country and circumstances in which subjects were living before arrival at New Zealand, the use of dietary supplements and for young children, whether they were fed breast milk or formula milk. Such information would help identify those likely to need ongoing monitoring of vitamin D status.

On the basis of this study, screening for vitamin D status of all refugees entering New Zealand is justified (acknowledging that rates may vary with annual differences in the type of ethnic groups received). Initial treatment is simple and inexpensive and may prevent clinical manifestations of poor vitamin D status. Single-dose treatment is recommended, which for adults with low vitamin D is 10 cholecalciferol (50 000 IU per tablet) tablets and for children is six tablets. Serum calcium levels should be checked at the time the vitamin D levels are measured, and if low, oral calcium supplements given for 1 week before giving the cholecalciferol tablets.[21] Such single-dose treatment can be explained and given in the presence of an interpreter thus improving compliance and providing an opportunity for education on consumption of calcium-rich and vitamin D-rich foods and need for ongoing supplementation, particularly for breast-feeding mothers and their infants.

Health professionals who work with refugees on an ongoing basis should also be aware of this important health issue, particularly in young women and adolescent girls who receive little sun exposure because of cultural restrictions. This study indicates though that low vitamin D is an issue across the age range. Therefore vitamin D status needs to be considered as a preventive health issue by a wide range of health professionals, including primary care practitioners, paediatricians and obstetricians.

Vitamin D deficiency remains an issue in many countries and across different population groups. Within New Zealand, a recent population-based national survey of school age children showed that 31% had a vitamin D level less than 37.5 nmol/L and 4% less than 17.5 nmol/L.[22] Vitamin D concentrations were lower in girls, in Pacific and Maori children and in children who were obese. An increased risk of vitamin D deficiency for Pacific and Maori adults aged 40–64 years has also been described.[18] A recent audit from a primary care practice serving a poor inner city population showed that 87% of pregnant women had a vitamin D level less than 50 nmol/L.[23] Thus this study confirms refugees as one of several at-risk population groups in New Zealand for vitamin D deficiency.

The re-emergence of vitamin D deficiency as a health issue in countries where it was thought to have been eliminated and its emergence in countries where risk was previously believed to be small stresses its increasing significance as a public health issue.[22,24–28] The need to fully understand the role that vitamin D plays in the prevention of chronic disease and protection against infection and malignancy has never been greater.[29]

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